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ABSTRACT

Explanations of age-related differences in adult memory usually assume two forms: processing deficits and structural deficits. Processing deficit explanations attribute recall differences to a failure of older adults to effectively use the processes of attention, organization, mediation (the use of such devices as visual images and verbal images and verbal expressions to link meaningful bits of information into integrated memorable whole), and elaboration (the use of a levels-of-processing approach for encoding bits of information in a systematic hierarchical fashion). Structural deficit explanations attribute differences to speed and capacity limitations associated with age-related changes in the central nervous system. Findings of discourse-learning studies suggest that characteristics of the adult learner interact with characteristics of the material to determine recall outcomes. Sex and educational background of older adults influence recall scores. It is possible that part of the observed age-related recall difference is due to metacognitive factors. (Metacognition is the general knowledge that guides selection and implementation of task-specific operations.) While older adults may fail to integrate seemingly trivial facts, they integrate meaningful new knowledge with existing related knowledge, ensuring high levels of recall. Activation of existing knowledge may help to moderate recall deficits in older adults. (Author/MN)

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A Contextual View of Adult Learning and Memory

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Abstract

In general, two explanations have been suggested for age-related differences in adult memory: processing deficits and structural deficits. Processing deficit explanations attribute recall differences to a failure of older adults to effectively use the processes of attention, organization, mediation, and elaboration. Structural deficit explanations, on the other hand, attribute recall differences to speed and capacity limitations that are associated with age-related changes in the central nervous system. The findings of discourse-learning studies suggest that characteristics of the adult learner interact with characteristics of the material to determine recall outcomes. In particular, the activation of relevant existing knowledge may help to moderate the recall deficits of older adults.

Learning Theory and Adult Cognitive Development

In general, reviews (e.g., Botwinick, 1978; Craik, 1977) of the adult verbal-learning literature support the following conclusion: young adults can recall word lists better than older adults. Explanations of this age-related difference in word-list recall usually assume two forms: processing deficits and structural deficits.

Processing Deficits

Processing deficit explanations attribute age-related differences in word-list recall to a failure of older adults to effectively use certain cognitive processes. These processes include attention, organization, mediation, and elaboration.

Attention. The results of visual-search experiments (Rabbitt, 1965, 1968) suggest that older people have attentional deficits which are manifested in verbal learning situations. For example, Rabbitt (1965) required young (mean age = 20 years) and older (mean age = 65 years) adults to sort cards on which letters were printed. The ratio of relevant to irrelevant stimuli (i.e., letters) was systematically varied. An analysis of sorting times indicated that older subjects required more time for inspection than young subjects. This difference became more pronounced as the amount of irrelevant stimulus information was increased. Related experiments (e.g., Kausler & Klein, 1978; Schonfield, Trueman, & Klein, 1972) employing word lists lend additional support to the notion that the aged have special difficulty discriminating important information from "perceptual noise."

Older adults are also limited in terms of the amount of verbal information they can perceptually register at one time. For instance, Schonfield and Wenger (1975) required young (range = 20-30 years) and older (range = 60-70 years) subjects to identify strings of letters. The number of letters per string was systematically varied . Older subjects were found to require more identification time than young subjects as the number of letters per string increased.

These experiments indicate that older adults are often penalized in verbal-learning situations that require them to discriminate relevant from irrelevant information and perceive several bits of information simultaneously. Since recall is necessarily limited by the amount of relevant information initially registered, attentional deficits may be responsible for observed differences in recall between young and older adults.

Organization. The retention of verbal information is dependent not only upon the perception or initial registration of the information but upon the organization of the information as well. Hultsch (1969, 1971, 1975) conducted a series of studies to identify the effects of organization on the recall of young and older adults.

Hultsch (1969) required young (mean age = 17.1 years) and older (mean age = 48.9 years) adults to learn a list of 22 words. All subjects received standard free-recall instructions; however, some were additionally instructed to "organize your recalled words alphabetically ...note their first letters, and make an attempt to associate the word with the letter" (Hultsch, 1969, p. 675). In general, subjects who received the additional, organizational instructions recalled more words than subjects who received only free-recall instructions. Older subjects, especially those with low verbal ability, benefited most from the organizational instructions.

In a related investigation with young (mean age = 24 years) and older (mean age = 64.2 years) adults, Hultsch (1971) used a word sorting procedure to study the effects of organization on recall. Under this procedure, participants repeatedly sorted 52 words into several categories until they produced two identical sorts. Young and older adults were not found to differ in terms of their sorting behavior; however, tests administered later revealed that older adults were unable to recall as many words as young adults. Interestingly, recall performance was poorest among a control group of older adults who did not first sort the words into conceptual categories. These findings taken together suggest that recall deficiencies in older adults can be reduced by activities that foster the development of organizational schemes.

In yet another study, Hultsch (1975) had young (mean age = 20.24 years) and older (mean age = 70.25 years) adults learn and recall 40 words. The words could be potentially grouped into 10 conceptual categories; the names (labels) of these categories were made available to individuals only under the cued condition. Overall, young adults recalled more words than older adults. More important, however, was the finding that older adults benefited most from the provision of organizational cues.

The foregoing studies suggest that older adults sometimes fail to chunk related bits of verbal information. As a result, the memory performance of older adults may be inferior to that of young adults in verbal tasks that place demands on their limited organizational abilities.

Mediation. Mediators link meaningful bits of information into integrated, memorable wholes. Mediational devices include visual images (e.g., pictures, graphs, symbols, and diagrams) and verbal expressions (e.g., single words, phrases, and rhymes) that are used to unify discrete propositions into ideational systems.

Hulicka and Grossman (1967) found evidence of mediational deficits among the elderly. In their investigation, young (mean age = 16 years) and older (mean age = 74 years) adults studied word lists under different instuctional sets. The results were as follows: (1) instructions to use various types of mediators were found to enhance the performance of both young and older subjects (relative to controls who were not instructed to use mediators); (2) older adults did not attain recall levels as high as those of young adults; and (3) in comparisor to young adults, older adults profited more from mediational instructions.

Gordon and Slevin (1975) studied the effects of mediators on the recall of entire sentences. Young (mean age = 24.2 years) and older (mean age = 68.3 years) learners read sentences that were classified as concrete or abstract. Young learners were found to recall more sentences of both types. When questioned about their use of strategies, young subjects reported equivalent use of verbal and visual (imaginal) mediators when encoding concrete sentences; many young subjects continued using visual mediators to process abstract sentences. In contrast, older adults used predominately verbal mediators to process both types of sentences.

In general, older adults may fail to use mediational strategies, particularly of the visual type, as often or as effectively as young adults. The inability to generate mediators and use them to integrate discrete, meaningful units may account, in part, for the poor verbal-learning performance of older adults (Canestrari, 1968; Hulicka & Grossman, 1967; Rowe & Schnore, 1971).

Elaboration. Within the context of adult development, a model of memory with considerable explanatory power is the levels-of-processing approach (Craik & Lockart, 1972; Craik & Tulving, 1975). In fact,

the attentional, organizational, and mediational deficit explanations discussed previously can be considered subsets of this model. The levels-of-processing approach posits that there is a unitary memory system within which encoding operations (such as, attention, organization, and mediation) are carried out in a systematic, hierarchical fashion.

The number and qualitative nature of operations applied to the incoming information determines how deeply the information is processed. A deep level of semantic analysis (elaboration) produces a strong, longlasting memory trace. Thus, the retention of input is considered to be a function of the degree to which the input is elaborated.

It has been hypothesized that deeper, more elaborate forms of encoding are performed less effectively by older adults. In order to test this "processing deficit hypothesis," Eysenck (1974) required young (range = 18 to 30 years) and older (range = 55 to 60 years) adults to perform the following incidental tasks: counting letters, making rhymes, generating relevant adjectives, and constructing images. Counting letters and making rhymes were thought to be nonsemantic tasks, whereas generating adjectives and images were thought to be semantic tasks. Results indicated that young and older adults exhibited similar levels of incidental recall following nonsemantic operations; however, young adults recalled more than older adults following semantic operations. Similar results have been obtained in more recent studies (e.g., Mason, 1979; Mueller, Rankin, & Carlomusto, 1979; Perlmutter, 1979; Simon, 1979; Zelinski, Walsh, and Thompson, 1978). In short, evidence exists which suggests "older adults may be less able than the young to process at deep levels, or alternatively, that the memory traces resulting from deep levels are less durable for the old" (Walsh, 1975).

Structural Deficiencies

Implicit in the processing deficiency explanations is the assumption that older adults can compensate for a particular deficiency by adopting various remedial strategies. Although strategies such as rhyming, chunking, and imagery can enhance older adults' recall of word lists, the use of these strategies still does not elevate older adults' recall to the level of young adults (e.g., Hultsch, 1961, 1971, 1975). Some theorists (Birren, 1974; Craik & Simon, in press) have suggested that it is impossible to equate recall performance because there are basic (structural) differences in the central nervous systems of young and older adults. Two specific differences have been hypothesized: speed of processing and capacity for processing.

Speed of processing. With age, perceptual and motor processes gradually slowdown (see Welford, 1979). This observation is by no means new. In fact, Birren (1964, pp. 111-112) concluded "evidence indicates that all behaviors mediated by the central nervous system tend to slow in the aging organism ... In the view favored here, slowness of behavior is the perceptual manifestation of a primary process of aging in the nervous system." More recently, Birren (Note 1) has suggested that a speed-of-processing deficit may explain age-related differences in recall. A study conducted by Lachman, Lachman, and Thronesbery (1979) provides support for this notion. In their study, young (mean age = 21 years), middle-age (mean age = 50 years), and older (mean age = 69 years) adults were asked 190 general knowledge questions about such topics as famous people, news events, literature, and sports. Subjects responded to these questions on the basis of their extraexperimental knowledge. The age groups did not differ in terms of total correct responses; however, they did differ in terms of their correct recall latencies. Middle-age adults and older adults required somewhat longer response times than young adults.

Processing capacity. The processing capacity of an individual has been defined as "the limited pool of energy, resources, or fuel by which some cognitive operations or processes are mobilized and maintained" (Johnston & Heinz, 1979, p. 422). In the context of aging and memory, Craik and Simon (in press) have speculated that the processing capacities, or alternatively, processing "resources" of older adults are deficient in some respect. As a result, older adults will perform more poorly than young adults on recall tasks that require large allocations of cognitive resources.

Adult Memory for Discourse

When the material to be learned is a list of words, it is clear that a deficit of some kind hampers the recall performance of older adults. In contrast, an age-related difference in recall is not consistently observed when the material to be learned is connected discourse (prose or text). In order to further explore this issue, literature concerning adult memory for discourse will be briefly reviewed.

Age-related differences present. Moenster (1972) studied memory for prose information with a sample of adults who were age-grouped in decades ranging from the twenties to the nineties. All subjects read a short, sixth-grade level story consisting of several paragraphs from the Iowa Silent Reading Elementary Test. Immediately after reading and again ten minutes later, subjects were administered a 20 item multiple-choice test. Results revealed that after the mid-thirties, increments in subjects' ages were paralleled by decrements in both immediate and delayed recall.

In a study conducted by Gordon and Clark (1974), young (mean age = 24.76 years) and older (mean age = 71.25 years) adults read a short paragraph about community action groups in a large city. The participants' retention of

paragraph information was assessed immediately after reading and again one week later. Several measures of information retention were employed. The recognition test was comprised of 32 true-false questions. One-half of these recognition questions were factual; that is, they were constructed from information explicitly stated in the paragraph. The other one-half of the true-false recognition questions were inferential in nature; it was necessary to combine two facts from the paragraph to derive the correct answer for each inference. Both the factual and the inferential recognition scores of older adults were found to be lower than those of young adults. This was observed to be the case when recognition was assessed immediately and again after a one week delay.

In addition to recognition tests, Gordon and Clark (1974) used a free-recall procedure to gauge individuals' ability to reconstruct text information without prompts (cues). Under this procedure, older adults reproduced fewer text "idea units" than young adults. Furthermore, this performance deficit was more pronounced on delayed recall than it was on immediate recall.

Taub (1976) required young (mean age = 27.5 years) and older (mean age = 67.7 years) adults to read a 975 work, college-level Diagnostic Reading Test passage about a natural science topic. After the text had been read, subjects responded to 15 multiple-choice questions. Consistent with the aforementioned findings, the recall performance of the older readers was inferior to that of the young readers.

In order to compare the practical abilities of young and older adults, Monge and Gardner (1976) administered the battery of Adult Basic Learning Examination tests to a sample consisting of males and females from each of the decades from the 20s through the 60s. The battery included a reading retention test that was intended to provide older adults with a meaningful

prose-processing task. The test required all participants to study a simulated newspaper for a predetermined period of time and then answer questions about the content. Data analyses indicated that the recall scores of males improved with age up to 60 years; after 60 years of age the recall performance of males declined. On the other hand, females exhibited progressively lower recall scores with age; after 50 years of age, their performance remained at a constant level.

The variation in the performance of males and females suggests that experiential factors (e. g., occupational requirements) may serve either to retard or accelerate age-related decrements in text-processing abilities. This conclusion is further supported by the finding that the educational background of older adults influenced recall scores. Adults with the most education exhibited declines in recall which tended to be later and less steep than those of adults with less education. In general, these findings suggest that older adults do not process textual material as efficiently as young adults. However, it is clear that for a given older individual, this loss in efficiency can be minimized if certain environmental stimulants are operating.

The results of the foregoing discourse learning studies are consistent with those of studies in which lists of words are learned. In general, older adults are unable to recall verbal material as well as young adults. Taken together, these studies provide strong support for the notion that the recall performance of older adults is hindered by either a processing or structural deficit of some kind.

Age-related differences absent. It is important to note, as Monge and Gardner (1976) did in their practical-ability tests, that age-related decrements in recall can be minimized by factors such as education and experience. In fact, Taub (1979) demonstrated that young (mean age = 27 years) and older

(mean age = 68 years) adults, with high levels of WAIS verbal ability, recall equivalent amounts of information from a passage.

Meyer, Rice, Knight, and Jessen (Note 2) required a college-educated population of young (mean age = 23 years), middle-age (mean age = 47 years), and older (mean age = 69 years) adults to study two technical passages. Recall protocols were scored for the number of passage idea units recalled. In addition, the position of idea units in the hierarchical structure of the passage was identified. Meyer et al. concluded:

> The data provided no support for claims of deficits in prose learning nor in the use of organization with aging.... It appears that the large age-related differences in performance on memory tasks found with laboratory-type tasks are substantially reduced or erased when meaningful prose materials are used.

The general knowledge that guides selection and implementation of task-specific operations (e.g., rehearsal, organization, elaboration, or imagery), is usually designated as metacognition. Such knowledge serves an executive function of coordinating and directing the thinking and behavior of learners. It clearly would be inappropriate to assume that learners in different stages of childhood implement similar strategies when confronted with the same complex information processing tasks. Because of their greater experience, older children sometimes have a different perception of task dimensions (i.e., materials, directions, and performance criteria) than young children (see Flavell, 1979). For this reason, young and older children may vary in their goals and the kind of processing operations they employ. Just as learners in various stages of childhood are inclined to use different strategies when confronted with complex tasks, learners in various stages of adulthood may also be inclined to process information in different ways. For example,

older adults may differ from young adults in the relevance they attribute to experimental tasks. If older adults do not recognize specific tasks (including discourse study) as relevant to their interests, tney may not activate appropriate strategies and knowledge stores.

Conclusions

It appears as though characteristics of the adult learner interact with characteristics of the verbal material itself to determine recall outcomes. The word-learning studies reviewed suggest that a processing or structural deficit of some kind does indeed hamper the recall performance of older adults. This deficit, however, is not always detected when more meaningful verbal materials (prose and text) are recalled.

Analyses of the total context in which learning occurs can help explain the variation in recall performance often exhibited by young and older adults. Part of this variation can be explained by processing or structural deficits; however, it is also possible that part of this variation is due to metacognitive factors. For example, when presented with a particular selection of discourse, older adults may be disposed to reduce interference and conserve their limited resources (Birren, 1969). As a result, they fail to integrate seemingly "trivial" experimental facts with their existing world knowledge. On the other hand, when a selection of discourse induces a meaningful learning set, older adults may integrate new knowledge with existing related knowledge, and thereby ensure high levels of recall. Thus, the activation of existing knowledge may help to moderate recall deficits in older adults.

In sum, young and older adults may perceive task dimensions differently and, as a result, formulate different goals and strategies. These strategies must first be identified, by protocol analyses and learner interviews, before accurate predictions of adult learning outcomes can be made.

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